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Dimensional Stability of Color-Changing Irreversible Hydrocolloids after Disinfection

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Abstract

Statement of Problem: Disinfection of dental impressions is a weak point in the dental hygiene chain. In addition, dental office personnel and dental technicians are endangered by cross-contamination.

***Objectives*:** This study aimed to investigate the dimensional stability of two color-changing irreversible hydrocolloid materials (IH) after disinfection with glutaraldehyde.

Materials and Methods: In this in vitro study, impressions were made of a master maxillary arch containing three reference inserts on the occlucal surface of the left and right maxillary second molars and in the incisal surface of the maxillary central incisors. Two types of color-changing irreversible hydrocolloid (tetrachrom, cavex) were used. Glutaraldehyde 2% was used in two methods of spraying and immersion to disinfect the impressions. The control group was not disinfected. Casts were made of type IV gypsum. The linear dimensional change of the stone casts was measured with a profile projector. For statistical analysis, Kruskall-Wallis and Mann-Witney tests were used ($\alpha=0.05$).

Results: By immersion method, the casts fabricated from tetrachrom were 0.36% larger in the anteroposterior (AP) and 0.05% smaller in cross arch (CA) dimensions; however, the casts prepared after spraying of tetrachrom were 0.44% larger in the AP and 0.10% smaller in CA dimensions. The casts made from Cavex were 0.05% smaller in the AP and 0.02% smaller in CA dimensions after spraying and 0.01% smaller in the AP and 0.003% smaller in CA dimensions after immersion. Generally there were not significant differences in AP and CA dimensions of the experimental groups compared to the control ($p > 0.05$).

Conclusions: Disinfection of the tested color-changing irreversible hydrocolloids by glutaraldahyde 2% did not compromise the accuracy of the obtained casts.

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Introduction

It is well-known that all impressions should be disinfected to avoid possible transmission of infectious diseases, such as hepatitis B, tuberculosis, herpes, and Acquired Immunodeficiency Syndrome (AIDS) [1]. Saliva-contaminated dental impressions serve as a source of infectious microorganisms to dental personnel who handle the impressions or casts made from them. Other microorganisms, although not normally pathogenic, may cause opportunistic infections, especially in immunocompromised individuals [2]. The literature varies markedly in concentration, type and immersion times of disinfection protocols, making it difficult to assess the most appropriate method. Disinfectants commonly used include sodium hypochlorite, glutaraldehyde, iodophor, and phenol [1-3]. In addition, there is a large range of branded impression materials (reversible and irreversible hydrocolloids, polysulphides, polyethers and silicones) and gypsum based model materials available which create many potential material/disinfectant combinations. The role of a disinfectant is dual, in that it must be an effective antimicrobial agent, yet cause no adverse response to the dimensional accuracy and surface texture features of the impression material and resultant gypsum cast. Controversy exists in the literature as to whether the disinfection process causes degradation or distortion of impressions [4-8]. The response of individual brands of impression materials and gypsum products to disinfection procedures is varied, suggesting a lack of compatibility between a protocol and a given material. Therefore, individual analysis of impression materials is required to determine the efficacy of a specific disinfection procedure [9].

Because irreversible hydrocolloid (IH) materials or alginate is one of the most used materials for making an impression, its disinfection is a very critical issue [3-5]. For having an impression without any infection and contamination, it can be immersed into disinfection solution. In this way, the whole surface of an impression and a tray would be disinfected. However, immersion of hydrocolloid impression materials is not recommended by some researchers, since they are hydrophilic and their dimension could be changed due to imbibitions [5]. Therefore, spraying method was proposed for some impressions that had lost their accuracy because of immersion. Disinfection of impressions by both spray and immersion has been evaluated in the past with widely varying results [5-9]. Tullner *et al.* [10] revealed that immersion of alginate impressions in a bleaching solution for 15 minutes can be corrosive. Merchant [11] stated that disinfection with immersion method had more advantages than other disinfecting methods. Instead of immersion, spraying has been suggested by Dental Association for those materials which are prone to dimensional variations [12]. Durr *et al.* [13] concluded that dimensional variations from disinfecting the impressions by both methods were not clinically significant, but the casts which were disinfected by spraying method had a higher accuracy.

Today some manufactures add pH dependent dyes to alginates materials to allow the course of polymerization to be followed visually so as to identify the correct time for the removal of the impression. Common pH dependent dyes are phenolphthalein and thymolphthalein. Additional ingredients, such as crystalline calcium sulfate, are reportedly required to make the pH dependent dyes work properly [14-16]. Although pouring impressions as quickly as possible is generally recommended, it is claimed that contemporary irreversible hydrocolloid impressions are dimensionally stable for up to several days [17]. Scientific evidence about this claim is lacking, however, Erbe *et al.* [18] showed that in general, the color-change IH materials studied had higher dimensional change values.

The authors did not find any research in regard to the effect of disinfection procedures on dimensional accuracy of color-changing irreversible hydrocolloids. Therefore, the aim of this study was to investigate the dimensional stability of color-changing alginate after immersion or spraying by glutaraldehye 2%.

Materials and Methods

In this in vitro study, the dimensional stability of two alginate impressions, tetrachrom (Herford, Germany) and Cavex (Haarlm, Netherlands), was evaluated indirectly by measuring the dimensions of stone casts. Impressions were taken from a master maxillary arch (Typodont). Three metallic stainless steel indexes were inserted on the occlucal surface of the right and left second molars and in the incisal surface of the central incisors which served as reference marks for measurements. The distance between the right second molars index and central incisors was considered as the anteroposterior (AP) dimension and that between the right and left molars index as cross arch (CA) dimension. All impressions were taken by a metallic perforated tray. Acrylic resin positioning indexes were fabricated to ensure uniform seating of the trays.

60 impressions were prepared and then divided into 6 groups of 10. Half of the impressions were prepared by tetrachrome and the rest by cavex. The tested groups of each material were as follows:

1. The control group (without disinfection) 2. Disinfection group with spray 3. Disinfection group with immersion.

For all of the impressions, the alginate powder was mixed with water according to the manufacturers' instruction. Then, the filled tray was placed on the model carefully until the positioning indexes were seated in position. Because of the temperature difference between the mouth and laboratory environment, the impressions were removed from the model after 5 minutes and then rinsed under running water for 1 minute. The impression in the control group was packed in a wet tissue and protected in a plastic bag lasting 10 minutes. In the immersion group, the impression was immersed in glutaraldehyde 2% (Cidex, Behsadex Co.) for 10 min. Finally in spraying group, glutaraldehyde 2% was sprayed over the surface of the impression. The impression was protected in a plastic bag for 10 minutes and then rinsed under running water for 1 minute. In the next step, 100 gr stone casts of type IV was mixed with 28 ml water. The impression was casted by die stone using a double pour technique. All the casts were removed from the impression after 1 hour.

The stone casts were measured with a Nikon profile projector of 1μm accuracy. The dimension was measured three times each and the average of the measurements was analyzed statistically. Kruskall-Wallis and Mann- Whitney tests were used for statistical analysis at α=0.05.

Results

According to Table 1, dimensions of tetrachrom after disinfection with immersion method showed an expansion of 0.36 % (103 µm) whereas in the spray group this expansion was 0.44 %, (129 µm) in AP dimension. CA dimension displayed a reduction of 0.05 %, (26 µm) and 0.10 % (46 µm) in the immersion and spraying groups, respectively.

However, cavex specimens exhibited dimensional reduction in both spraying and immersion methods compared to the control group. The mean changes are as follows:

-0.01% (3 µm) immersion group, AP dimension

- 0.05 % (13 µm) spraying group, AP dimension

-0.003 % (0.7 µm) immersion group, CA dimension

-0.02 % (13 µm) spraying group, CA dimension

Table 1: Mean Percentage of dimensional change compared to the control (mm)

Impression Materials	Spraying (AP)	Immersion (AP)	Spraying (CA)	Immersion (CA)
Tetrachrom	(+)44%	(+)36%	(-)0.10%	(-)0.05%
Cavex	(-)0.05%	(-)0.01%	(-)0.02%	(-)0.003%

(+)= Expansion (-)= Shrinkage

The results of the present study showed that changes in AP and CA dimensions of the experimental groups compared with the control group were not statistically significant ($p<0.05$). Also, there were no significant differences in AP and CA dimensions of cavex and tetrachrom after disinfection by spray or immersion method ($p>0.05$). The mean and standard deviation of the measured dimensions of the disinfected groups are displayed in Table 2.

Discussion

Because of the increasing number of patients infected with hepatitis, herpes virus, and AIDS, the dental profession has become acutely aware and concerned that their environment is a potential source of infectious diseases [1,2]. The potential for cross-contamination is exacerbated because spores, viruses, and bacterial microorganisms of these diseases can survive for prolonged times away from their natural habitats. Impression materials and prostheses that have been exposed to infected saliva and blood provide a significant source for cross-contamination [3]. Nevertheless, 35.4% of the dental professionals did not accomplish any type of disinfection of impressions because they thought that such procedure could cause dimensional changes in the materials [8,11]. Considering this evidence, researchers have proposed other alternative for disinfection of impressions. Studies have demonstrated the effectiveness of methods such as alginates containing antimicrobial agents in its composition, or even the use of disinfectants as substitutes of water in preparation of alginate. Other studies showed the inefficacy of procedures such as ultraviolet radiation, washing and immersion or casts in solutions, or the use of disinfectants as substitutes of water in preparation of dental plaster [19-22].

The spray technique shows a similar antimicrobial activity compared to the immersion method. However, in agreement with our study, the spray does not affect the dimensional stability as the process of immersion and this difference is not observed with a time period of 10 minutes for disinfection [6-10].

The method employed in this investigation took into account the recommendation of several authors [7,8,11,14] indicating that 10 minutes of immersion in the two solutions tested are enough to eliminate the viable bacteria from the surface of the condensation silicon. However, the need for an antispore effect highlighted the importance of verifying the effects when this time period was increased up to 20 minutes.

Even though procedures to test the effectiveness of the disinfectant solutions against AIDS and hepatitis B virus have not been developed yet, it is apparent that immersion for 10 minutes in high-level germicide such as a sodium hypochlorite solutions or potentiated glutaraldehyde will allow the achievement of a material with a virus-free surface [13].

In the present study, after disinfection of the alginate impressions with spraying and immersion techniques, no significant differences occurred in the anteroposterior (AP) and cross-arch (CA) dimensions compared to the control group. Also, the dimensional changes of both hydrocolloid materials were relatively the same with each other.

Matyas *et al.* [19] evaluated the effect of different disinfections on the accuracy of IH and silicon materials. The result exhibited the most dimensional variations in irreversible hydrocolloid and the least changes in silicon impressions. There was no significant difference between the methods of disinfection with spraying and immersion methods, which are consistent with our results.

According to Johnson *et al*. [20], studies on dimensional stability of alginate after disinfection with immersion method showed that it is acceptable to use these impressions for preparing diagnostic and opposing casts, as well as removable partial denture construction due to their high accuracy.

Table 2: Means and SD for all dimensions (AP and CA) of the tested groups (mm)

Impression Materials	Spraying (AP)	Immersion (AP)	Spraying (CA)	Immersion (CA)	Control (AP)	Control (CA)
Tetrachrom	29.03±2.01	29.01±2.06	44.8±4.10	44.86±3.22	28.81±1.10	44.80±2.43
Cavex	29.02±2.10	29.05±1.90	44.84±3.01	44.86±3.21	29.03±1.02	44.84±2.01

AP= Anterior-Posterior dimension, CA= Cross-arch dimension

In the present study, dimensional variations of tetrachrom with spraying and immersion methods were at least 26 μm (immersion group in CA) and at most 131μm (spraying group in AP), whereas for cavex these changes were 0.7 μm as the minimum (immersion group in CA) and 13 μm as the maximum (spraying group in AP). Thus, dimensional variations after disinfection with spraying and immersion methods are not clinically significant.

An important question is one of the maximum acceptable dimensional changes. Most studies identify the first point in time at which a significant dimensional change of the impression occurs when compared to the controls. This criterion is, however, of limited importance because significant differences may not be clinically relevant and vice versa. An important shortcoming is that the literature lacks important information about the threshold at which the dimensional accuracy becomes clinically unacceptable. Values given range from 0.1% to 0.8% [23]. However, the amount of distortion in the mandible with opening, during impression making, is in the range of 0.1 to 0.5 mm and there is an order of magnitude larger than the dimensional changes accompanying disinfection of impressions (0.01 to 0.04 mm) [20]. Therefore, in our study the distortion due to disinfection was negligible and that irreversible hydrocolloid can be safely disinfected by immersion with any of the disinfection methods used in this study.

Conclusions

Based on the results, for achieving the main purposes of alginate impressions including the preparation of diagnostic casts, opposing casts, removable partial denture construction , it is beneficial to use glutaraldehyde 2% for disinfecting the impressions with spraying or immersion methods. Also, it was verified that alginate specimens in both spraying and immersion methods were equal in dimensional stability and this alternation was not statistically or clinically significant.

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